Distribution, Behavior, and Reproductive Success of Outplanted Hatchery Spring Chinook Salmon in Shitike Creek, OR

Progress Report for 2002
And
Work Plan for 2003

David M. Hand, Doug E. Olson, Rod O. Engle, and Thomas A. Hoffman
United States Fish and Wildlife Service, Columbia River Fisheries Program Office
9317 NE Highway 99, Suite I, Vancouver, WA 98665
http://columbiariver.fws.gov

Bob Spateholts and Geoff FitzGerald
Confederated Tribes of the Warm Springs Reservation of Oregon
Department of Natural Resources
Warm Springs, OR
bspateholts@wstribes.org
gfitzgerald@wstribes.org

July 2003

Contents

List of Figures

List of Tables

Introduction

In the late summer of 2000 the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO) and the United States Fish and Wildlife Service (Service) initiated an adult spring Chinook salmon (*Oncorhynchus tshawytscha*) outplanting program in Shitike Creek, a tributary of the Deschutes River located entirely within the Warm Springs Indian Reservation. Shitike Creek flows approximately 61km from its headwaters near Mt. Jefferson before entering the Deschutes River at Rkm 155 (Figure 1). Shitike Creek and the Warm Springs River are the only tributaries of the Deschutes River that currently support natural spawning populations of spring Chinook salmon. Warm Springs National Fish Hatchery, located on the Warm Springs River (Figure 1), produces a hatchery run of spring Chinook that supports both Tribal and sportfishing harvest opportunities in the Deschutes River and in the main-stem of the Columbia River. The hatchery is cooperatively managed by the Service and the CTWSRO to protect wild spring Chinook and steelhead (*Oncorhynchus mykiss*) populations in the Warm Springs River subbasin. As part of this management plan, the majority of returning adult hatchery fish are harvested or taken into the hatchery. Returns of wild spring Chinook salmon to a fish ladder located at Warm Springs National Fish Hatchery (Rkm 16) from 1978 to 2002 have averaged 1313 fish (SD=659, range of 237 to 2705). The density, or redds per mile, of spawning spring Chinook in Shitike Creek is much lower than in the Warm Springs River and it is thought that the habitat in Shitike Creek is under-seeded (Lindsay *et al*. 1989). A water intake dam was built on Shitike Creek (Rkm 11.5) in the mid-1960's that blocked upstream movement of adult salmon and restricted spring Chinook spawning to the lower section of the creek. The water intake dam was removed in 1983. Habitat improvements and fish passage projects have been ongoing in Shitike Creek since removal of the intake dam. Despite these efforts, natural production of spring Chinook salmon in the drainage remained at relatively low levels. Indexed redd counts in Shitike Creek, conducted annually since 1986, ranged from a low of six in 1996 to a high of 33 in 1997 (CTWSRO unpublished data; Figure 2).

Shitike Creek also supports a population of summer steelhead that is part of the Mid-Columbia ESU listed as a threatened species, resident rainbow trout (*Oncorhynchus mykiss*), and bull trout (*Salvelinus confluentus*) that are part of the Columbia River distinct population segment that is listed as a threatened species. The CTWSRO have monitored summer steelhead populations in Shitike Creek since the early 1990's and bull trout populations since 1998 (Brun and Dodson 2001; CTWSRO unpublished data). Summer steelhead appear to spawn and rear throughout the lower 40 Rkm of the creek while bull trout spawn and rear primarily in the upper sections of the creek, above approximately Rkm 30 (Brun and Dodson 2001). Based on spring Chinook indexed redd counts and snorkel surveys conducted by the tribes, spring Chinook primarily spawn and rear in habitats below Rkm 40, in approximately the same distribution as summer steelhead

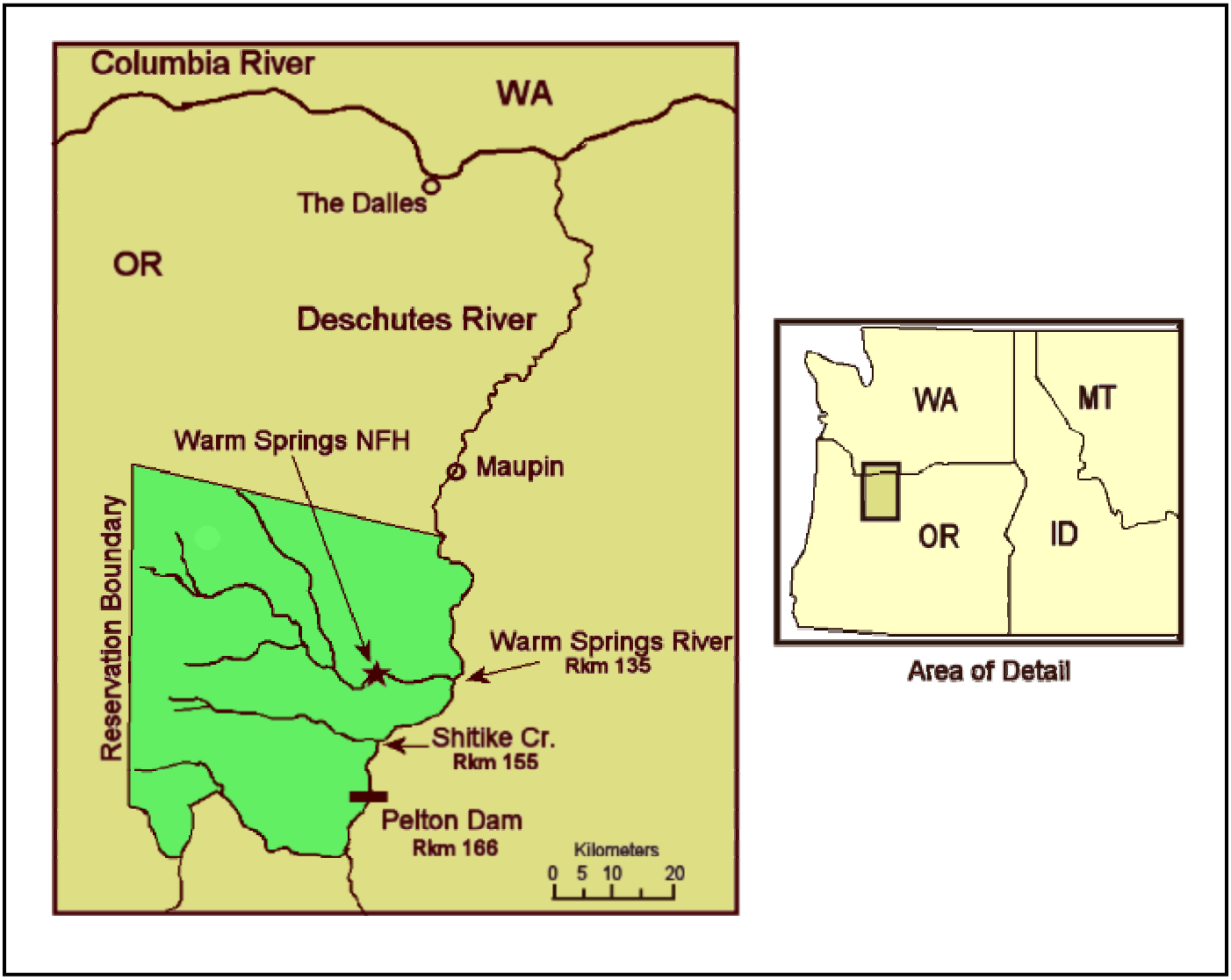

Figure 1. Map of Shitike Creek, the Warm Springs River, Warm Springs National Fish Hatchery, and boundaries of the Warm Springs Indian Reservation.

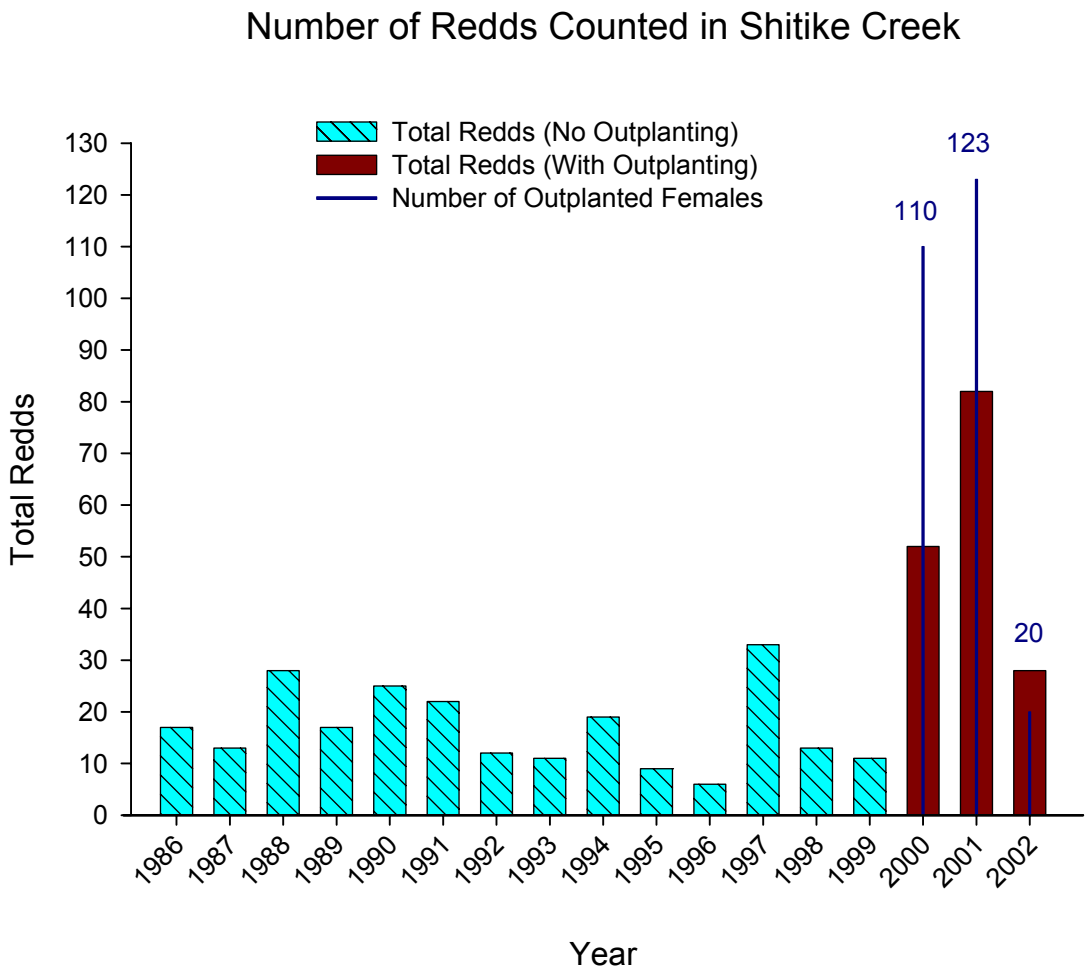

Figure 2. Number of redds counted in Shitike Creek 1986-2002 (CTWSRO unpublished data). The number of outplanted females is listed for years with outplanting.

During the summer of 2000 the Service and the CTWSRO initiated an adult outplanting program. This outplanting program is designed to boost the spawning population of spring Chinook salmon in Shitike Creek by releasing adult hatchery spring Chinook salmon from Warm Springs National Fish Hatchery into the Shitike Creek just prior to spawning. The hatchery has a broodstock collection goal of 630 spring Chinook salmon for normal hatchery operations. The hatchery began collecting an additional 200 hatchery spring Chinook salmon for the outplanting program. Returning hatchery fish are collected for broodstock and outplanting proportionately throughout the run based on wild Warm Springs River stock run-timing (Warm Springs NFH Operational Plan 2002-2006). During spawning days at the hatchery, usually in late August and early September, the CTWSRO loads fish for outplanting into an aerated tank truck and hauls them to one of five sites on Shitike Creek (Figure 3). The hatchery fish are released into the stream and are allowed to spawn naturally.

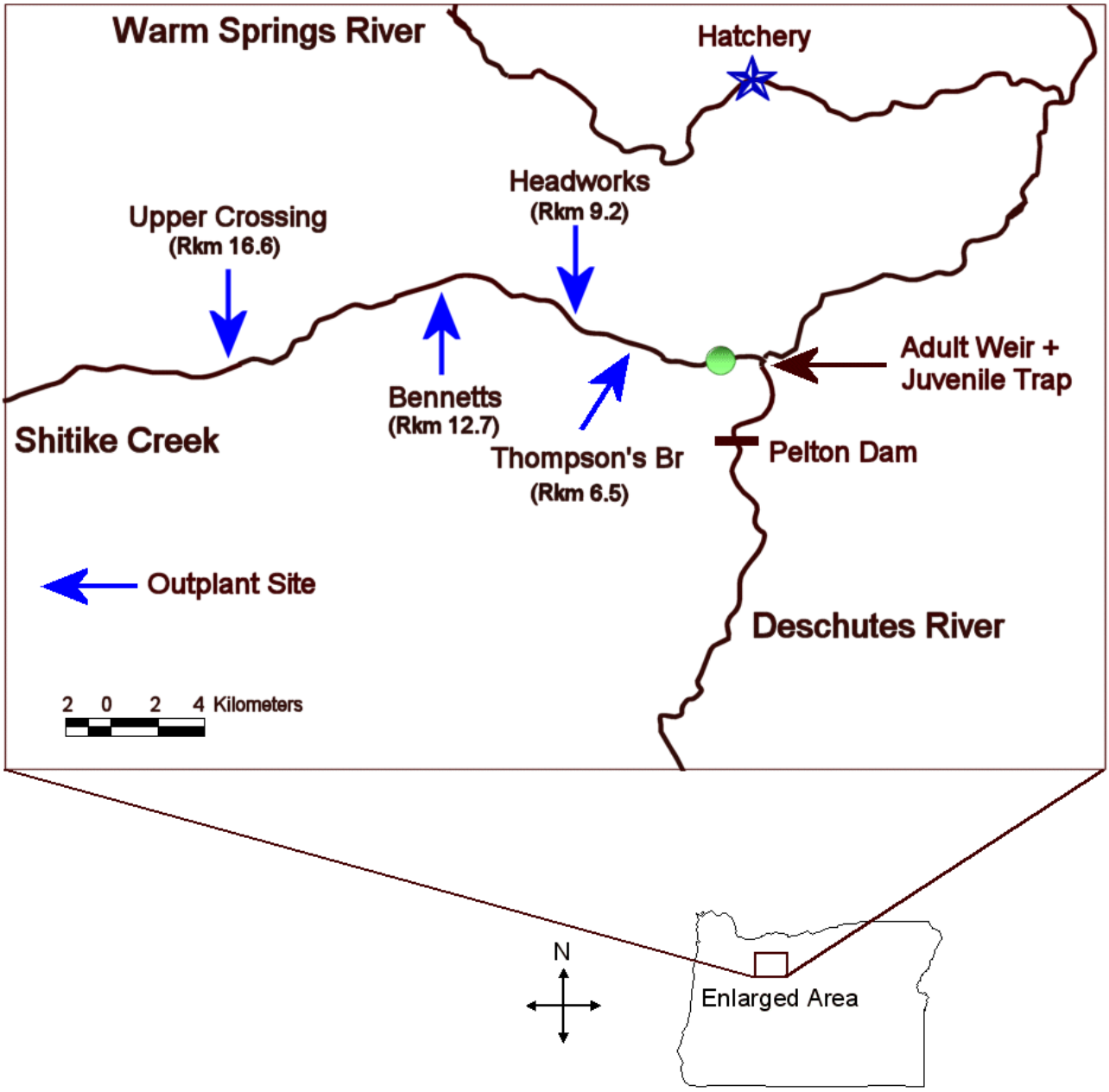

Figure 3. Outplanting locations, location of the adult weir and juvenile trap, and the location of Warm Springs NFH. The outplanting location at Peter's Pasture (Rkm 40) is not shown on this map.

In 2000, a total of 159 hatchery spring Chinook salmon were released at five outplant sites in Shitike Creek. The five sites were selected by the CTWSRO based on access considerations and an estimation of available spawning habitat in different reaches of the creek. The five outplant sites, shown in Figure 3, are as follows: Thompson's Bridge (Rkm 6.5), Headworks (Rkm 9.2), Bennetts (Rkm 12.7), Upper Crossing (Rkm 16.6), and Peter's Pasture (Rkm 40). The goal of the program is to annually release 200 hatchery spring Chinook salmon into Shitike Creek, although the actual number outplanted has varied according to returns to the hatchery and broodstock needs (Table 1). Since hatchery broodstock fish and fish for outplanting are collected throughout the run, the sex-ratio of the outplanted fish reflects the sex-ratio of returning Warm Springs hatchery fish.

Table 1. Number of hatchery spring Chinook salmon outplanted into Shitike Creek. Lower numbers in 2002 were due to high pre-spawning mortality (see Results section).

Year	*Male*	*Female*	*Total*
2000	49	110	159
2001	75	123	198
2002	63	20	83

The contribution of the outplanted hatchery fish to the spawning population is not known but it is assumed that some of the outplanted fish successfully spawned. Outplanted hatchery fish are selected from hatchery fish at Warm Springs National Fish Hatchery, whose life history traits closely mimic those of the wild population in the Warm Springs River (Olson and Spateholts 2001). The spawning success of hatchery spring Chinook salmon from the Warm Springs hatchery in the natural environment is not known. Several studies have shown a difference in performance and behavior between wild and hatchery adult fish (Reisenbichler and Rubin 1999). Burgert *et al*. (1991) reported that wild spring Chinook adults behaved differently from hatchery adults in the Tucannon River and selected spawning sites further upstream than hatchery fish. Since salmon mating is non-random, any differences in aggressiveness, size, spawning time, or other life history trait between hatchery and wild fish could potentially limit the amount of interbreeding (Quinn 1997). Information on the morphological, behavioral, and life-history characteristics of both the outplanted hatchery fish and natural-origin fish is needed in order to effectively monitor the success and/or impacts of the program.

The Service and the CTWSRO received funding in 2002 to evaluate the outplanting program in Shitike Creek and investigate potential ecological interactions between wild and hatchery fish. As part of this evaluation, the Service and the CTWSRO have implemented a program to assess the

distribution, behavior, and reproductive success of outplanted hatchery spring Chinook salmon in Shitike Creek. The two objectives of the evaluation are to 1) assess the distribution and behavior of outplanted spring Chinook salmon in Shitike Creek using radio-telemetry, and 2) estimate the reproductive success of natural-origin and outplanted hatchery-origin spring Chinook salmon in Shitike Creek using pedigree analyses. This report summarizes the work done in 2002 as part of the Shitike Creek evaluation program.

Methods

Adult Radio-Telemetry

Warm Springs National Fish Hatchery has a broodstock collection goal of 630 spring Chinook salmon for normal hatchery operations and 200 spring Chinook salmon for the Shitike Creek outplanting program. Returning hatchery fish were collected proportionately throughout the run, based on wild Warm Springs River stock run timing, for the hatchery broodstock and the outplanting program (Warm Springs NFH Operational Plan 2002-2006). Fish collection in 2002 was complicated by a high pre-spawning mortality of spring Chinook salmon in the hatchery brood ponds, mostly due to high *Ichthyophthirius* (*Ich*) levels in the returning fish (Susan Gutenberger, USFWS, pers. comm.). A total of 401 hatchery fish died in the brood ponds prior to spawning. As a result of the high pre-spawning mortality and the need to meet the hatchery's broodstock requirements, the majority of fish in the brood ponds were used for broodstock and not for outplanting. In 2002, 508 hatchery fish were spawned for brood purposes, resulting in very few fish being available for the outplanting program. As a result of the low numbers of fish available for outplanting, the CTWSRO and the Service decided to outplant hatchery fish that were progeny of eggs taken from Round Butte Hatchery, a state hatchery located on the Deschutes River at Pelton Dam (Rkm 166), and raised/released from the Warm Springs Hatchery. Surplus Warm Springs Hatchery jack salmon were also used in 2002. Although the founding broodstock of Round Butte Hatchery was collected at Sherars Falls on the Deschutes River and most likely consisted of Warm Springs River stock fish, the performance of Round Butte Hatchery stock spring Chinook salmon in the wild is not known since the hatchery is not managed to maintain wild spring Chinook salmon life-history characteristics. The use of the Round Butte stock in the outplanting program in 2002 was a temporary measure in response to the low numbers of returning fish and future outplants are expected to be entirely from Warm Springs Hatchery stock.

Outplanting of hatchery fish into Shitike Creek occurred on 23 August, 29 August, and 3 September. On days when fish were outplanted, hatchery staff sorted fish in the hatchery brood ponds and selected fish for outplanting. Fish were selected based on the presence of an adipose and left-ventral fin-clip (indicating that they were progeny of Round Butte Hatchery eggs). Selected fish were then crowded (2-8 fish at a time) into a hydraulic basket filled with water and a mixture of MS-222 anesthetic and buffer solution. Once fish were anesthetized, the hydraulic basket was raised up and fish were sent, one at a time, to a measuring table. All outplanted fish were measured, a small fin-clip was collected, and a colored floy-tag was attached to the dorsal fin. Fish that were not radio-tagged were immediately placed into a 300 gallon, aerated tank-truck operated by the CTWSRO. The total time that fish were out of the water for measuring and floy-tagging was less than 45 seconds.

Based on a total of 200 fish available for outplanting, seven loads of fish (approx. 30 fish per load) were to be outplanted. A total of twenty radio-transmitters were available for tagging in 2002. In order to focus the study on the redd locations of outplanted fish, a tagging ratio of two radio-tagged females to one radio-tagged male was used. Due to the high pre-spawning mortality of fish in the brood ponds at the hatchery, only 83 fish were available for outplanting in 2002. With the reduced number of fish available for outplanting (83 instead of the program goal of 200) and concerns about spreading disease into areas of Shitike Creek where bull trout rear, outplanting in 2002 was limited to the three lower-river outplant sites. The three lower-river outplant sites were Thompson's Bridge (Rkm 6.5), Headworks (Rkm 9.2), and Bennetts (Rkm 12.7) (Figure 3).

A total of eighteen outplanted fish were externally fitted with radio-transmitters. Coded radio-transmitters (Lotek Wireless; model MCFT-3CM), weighing 6.7 grams and having an estimated operational life of 65 days were used for this study. Fish selected for radio-tagging were processed in the same manner as fish that were not radio-tagged, except a floy-tag was not attached. Once the fish was measured and a fin sample was taken, the fish was placed, dorsal side up, in a v-shaped aluminum holder. The holder had a plastic covering at one end that draped over the head of the fish and helped calm the fish while the radio-transmitter was attached. Radio-transmitters were externally attached just below the anterior portion of the dorsal fin, with the antenna directed posteriorly (Nigro and Ward 1985). Two septum-surgical needles were used to thread a narrow-gauge wire through the base of the dorsal fin and through holes drilled in the radio-transmitter. The needles were pulled through and two red Peterson disk-tags were threaded on the wire. The protruding end of the wire was then twisted to secure the radio-transmitter against the fish's dorsal fin (Figure 4). Fish were then placed into the 300 gallon aerated tank truck.

Once the tank truck was loaded with between 15 and 30 fish, the fish were transported to one of the outplant locations and released (Figure 3). Fish were released into the stream by attaching a flexible tube to the back of the tank truck and flushing the water out of the tank truck. Outplanting occurred during the morning hours, when water temperatures were lower, in order to reduce stress on outplanted fish.

In 2002, 58 ADLV-clipped males, 5 AD-clipped jacks, and 20 ADLV-clipped females were outplanted at three locations in Shitike Creek. Between three and eight radio-tagged fish were released per load, with a total of six radio-tagged males and twelve radio-tagged females (Table 2).

Table 2. Number and location of adult hatchery spring Chinook salmon outplanted into Shitike Creek in 2002. The number of fish radio-tagged is in parentheses.

Location	*Male*	*Jack*	*Female*	*Total*
Thompson (Rkm 6.5)	21 (1)	3	7 (3)	31 (4)
Headworks (Rkm 9.2)	11 (1)	-	3 (2)	14 (3)
Bennetts (Rkm 12.7)	26 (4)	2	10 (7)	38 (11)
Total	58 (6)	5	20 (12)	83 (18)

A telemetry fixed-site station was set up near the mouth of Shitike Creek (Rkm 0.5) in order to monitor movement of radio-tagged fish out of Shitike Creek. The fixed-site station consisted of a four-element Yagi antenna mounted in a tree approximately 15 feet above the creek and a Lotek SRX-400 continuous data-logging receiver (W7 Firmware). Mobile tracking of tagged fish occurred two to three days per week using a foldable three-element Yagi antenna and a Lotek SRX-400 receiver (W5 Firmware). Sections of the stream, ranging from 2-8 km in distance, would be walked by a pair of surveyors during tracking days. Radio-tagged fish were mobile tracked in order to determine movement from outplant sites, redd locations, and fish behavior. When possible, fish locations were triangulated and visual observations of radio-tagged fish were recorded. Approximate locations of fish were recorded using a Garmin eTrex Vista handheld GPS unit, when coverage was available, and recorded on a map.

If a fish was located actively using or near a redd, redd locations were recorded and flagged. The origin, sex, and behavior of any other spring Chinook salmon in the vicinity of the radio-tagged fish was also recorded. In situations where a visual observation of the fish was not possible, fish position was estimated and no behavior was recorded. Radio-tagged fish were tracked until the fish was presumed to have died. An attempt was made to recover carcasses of radio-tagged fish and estimate the extent of spawning based on gamete retention. The extent of spawning was classified as either spawned out, partially spawned out, unspawned, or unknown. Mobile tracking and fixed-station monitoring occurred from 23 August, the first outplanting day, to 19 September, when all radio-tagged fish were presumed to have died.

The distance that a radio-tagged fish traveled from an outplant site was estimated using GPS coordinates or estimating the fish location on a map and interpolating between known distances. Mean travel distances were calculated for fish based on sex, outplant location, and outplant time. Due to unequal variances between samples, median distances were compared using the Mann-Whitney test (Zar 1984).

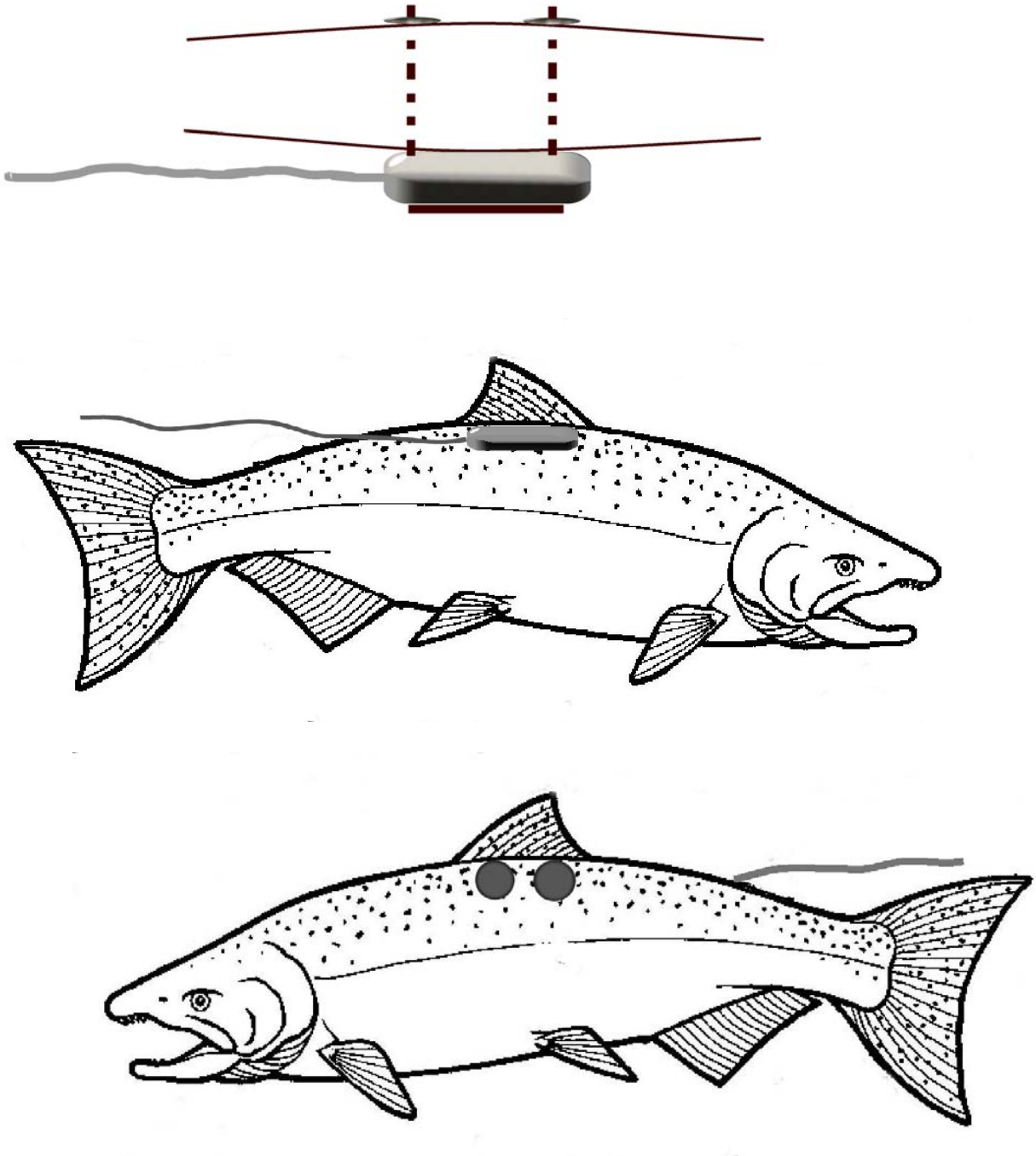

Figure 4. Overhead, right, and left side view of radio-transmitter attachment. Radio-transmitters were Lotek Wireless model MCFT-3CM. A narrow gauge wire was threaded through holes drilled in the transmitter and then through the base of the dorsal fin and two Peterson disk-tags on the other side of the fish.

Reproductive Success

The Service and the CTWSRO developed a genetic monitoring program designed to evaluate the reproductive success of outplanted hatchery-origin and natural-origin spring Chinook salmon in Shitike Creek. Tissue samples were to be collected from all outplanted and natural-origin spring Chinook salmon in Shitike Creek. In subsequent years, in addition to the continued collection of tissue samples from all adults, tissue samples will be collected from a minimum of 1000 juvenile fish from each brood year. Methods for collecting juvenile samples are discussed in the 2003 Work Plan. Based on 100% sampling of the adults and a subsampling of the juveniles, a pedigree analysis was to be used to determine the parents of the subsampled juveniles. Sampling was to continue for five years and a comparison of the relative reproductive success of outplanted and natural-origin was to be monitored (William Ardren, USFWS, pers. comm.).

In 2002, an adult weir was installed near the mouth of Shitike Creek (Rkm 1) that allowed CTWSRO and Service personnel to count and sample adult spring Chinook salmon that migrated up Shitike Creek. The sampling protocol called for the collection of fin tissue and size information from all stray hatchery or wild spring Chinook salmon entering Shitike Creek. Fin tissue samples, an approximately $1cm^2$ clip of the dorsal fin, were to be used for genetic pedigree analysis of the relative reproductive success of outplanted and non-outplanted spring Chinook. In 2002, a flood event washed out the adult weir in the early spring. The weir was out of operation for approximately one month before it was repaired. When the weir was operational it was monitored four days a week, the other three days pickets were removed that allowed fish to move upstream without being sampled. Fin-clips of all outplanted fish were collected at the hatchery as the fish were sorted for outplanting. The fin-clips were stored individually in labeled vials containing 100% ethanol.

Results

Adult Radio-Telemetry

Of the 18 radio-transmitters that were attached to outplanted fish, four radio-transmitters were known to have fallen off of the fish at some point after their release into the stream. Another three radio-tagged fish were never visually observed and may have lost their radio-transmitters (Table 3). All four of the radio-transmitters that were known to have fallen off were from the first outplant group on 23 August. Transmitters attached on the 23rd were recovered in the creek at locations up to 8.7 Rkm away from the release location, indicating that the transmitters did not immediately fall off of the fish after outplanting. It was thought that the attachment wires of the radio-transmitters were loosened up during the release of fish from the tank truck. Attachment techniques were modified after 23 August to include a multiple twist/loop of the protruding end of the wire that was used to attach the radio-transmitter to the fish. Tag retention increased with the new attachment method. No radio-transmitters were known to have fallen off after the change in attachment technique, although three radio-tagged fish were never visually observed (Table 3).

The distance that outplanted radio-tagged fish moved from the release sites ranged from 0.2 Rkm to 11.2 Rkm (Figure 5). Due to unequal variances, median distances were used to compare the distance traveled by males and females (Figure 6). The median distance traveled for all outplanted fish was 2.4 Rkm. Males traveled farther than females ($U=65$, $p=0.0025$). The distances traveled should be considered a minimum since some radio-transmitters became detached from the fish before they spawned or completed their movement. One fish, released at Headworks (Rkm 9.2), migrated out of Shitike Creek and into the entrance of the fish ladder at Pelton Dam on the Deschutes River (Rkm 166) (Figure 7).

Table 3. Summary of the extent of spawning and behavior for 18 outplanted, radio-tagged spring Chinook salmon in Shitike Creek in 2002.

Outplant date	*Outplant location*	*Sex*	*Distance(km)*[a]	*Extent of spawning and behavior*[b]
8/23	Bennetts	M	8.8	Unknown (tag fell off)
8/23	Bennetts	M	10.4	Unknown, no visual
8/23	Bennetts	M	7.2	Unknown (tag fell off)
8/23	Bennetts	F	4.3	Unknown (tag fell off)
8/23	Bennetts	F	0.2	Unknown (tag fell off)
8/23	Bennetts	F	(1.6)	Unknown (tag fell off)
8/23	Bennetts	F	4.3	Unknown, on redd
8/29	Thompson	M	(0.8)	Unknown, unspawned?
8/29	Thompson	F	(0.2)	Unspawned, near redd
8/29	Thompson	F	(0.3)	Unspawned, on redd
8/29	Thompson	F	(0.2)	Unknown, no visual
8/29	Headworks	M	(11.2)	Unknown, out of Shitike
8/29	Headworks	F	0.3	Unspawned
8/29	Headworks	F	0.3	Unknown, no visual
9/3	Bennetts	M	2.9	Unknown, on redd
9/3	Bennetts	F	2.4	Spawned out, on redd
9/3	Bennetts	F	2.7	Unknown, on redd
9/3	Bennetts	F	2.7	Unknown, carcass

[a]*Distance is the maximum distance from outplant site that the tag was detected. Distances in parentheses are downstream from outplant sites.*

[b]*Extent of spawning was determined when carcasses were recovered.*

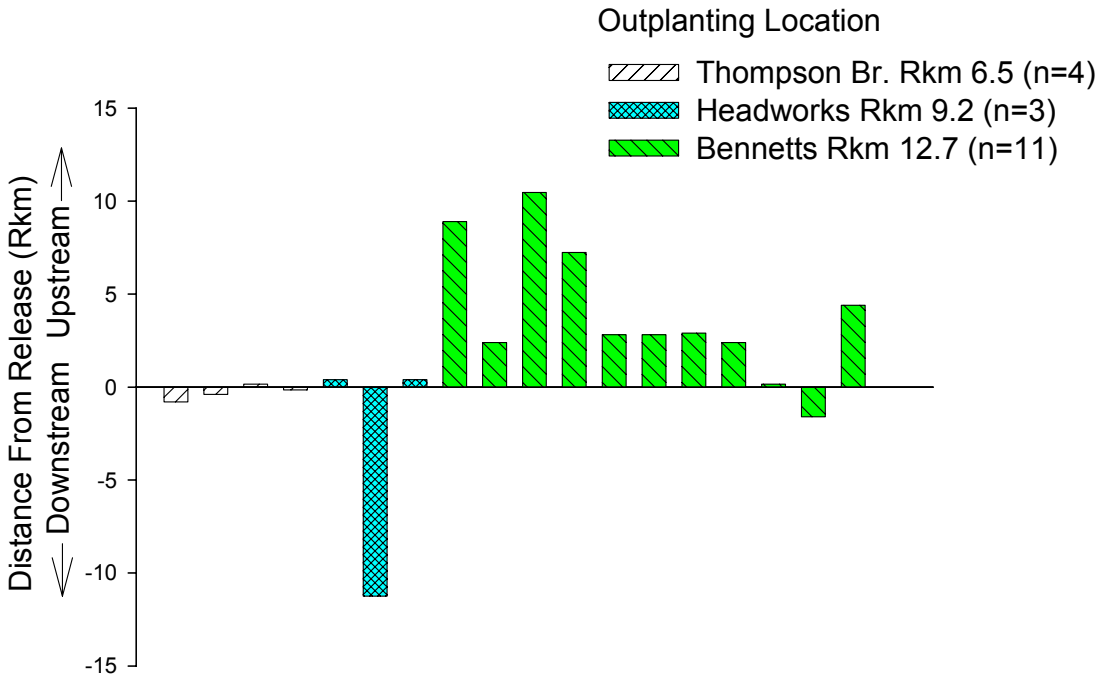

Figure 5. Maximum migration distance from outplanting location of radio-tagged fish in Shitike Creek, 2002 (n=18).

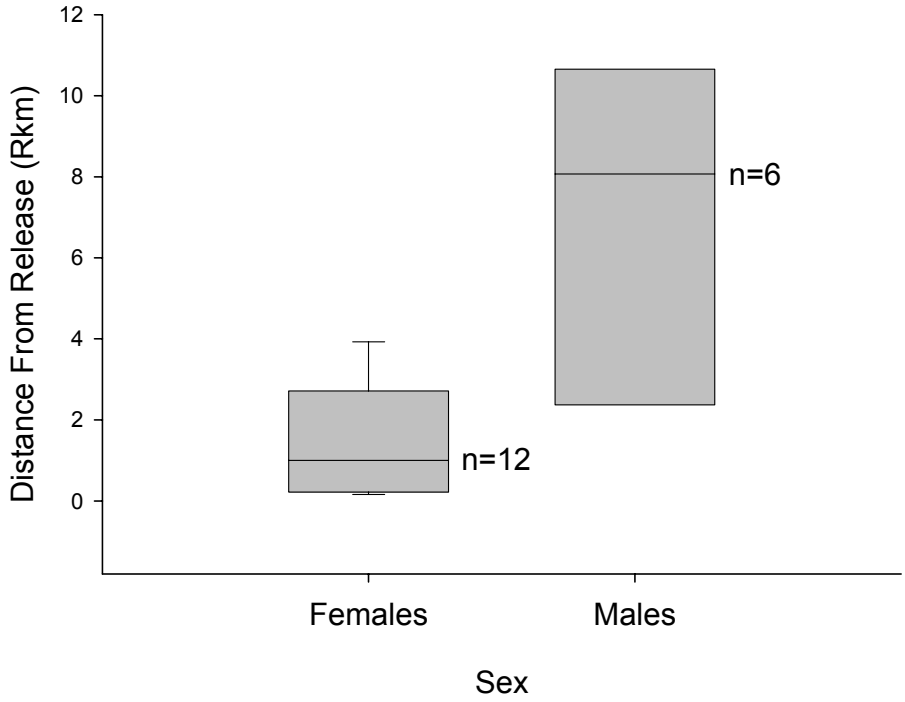

Figure 6. Median distance traveled by radio-tagged fish outplanted into Shitike Creek, 2002 (n=18). Boxes represent the 25th and 75th percentiles, whiskers represent the 10th and 90th percentiles.

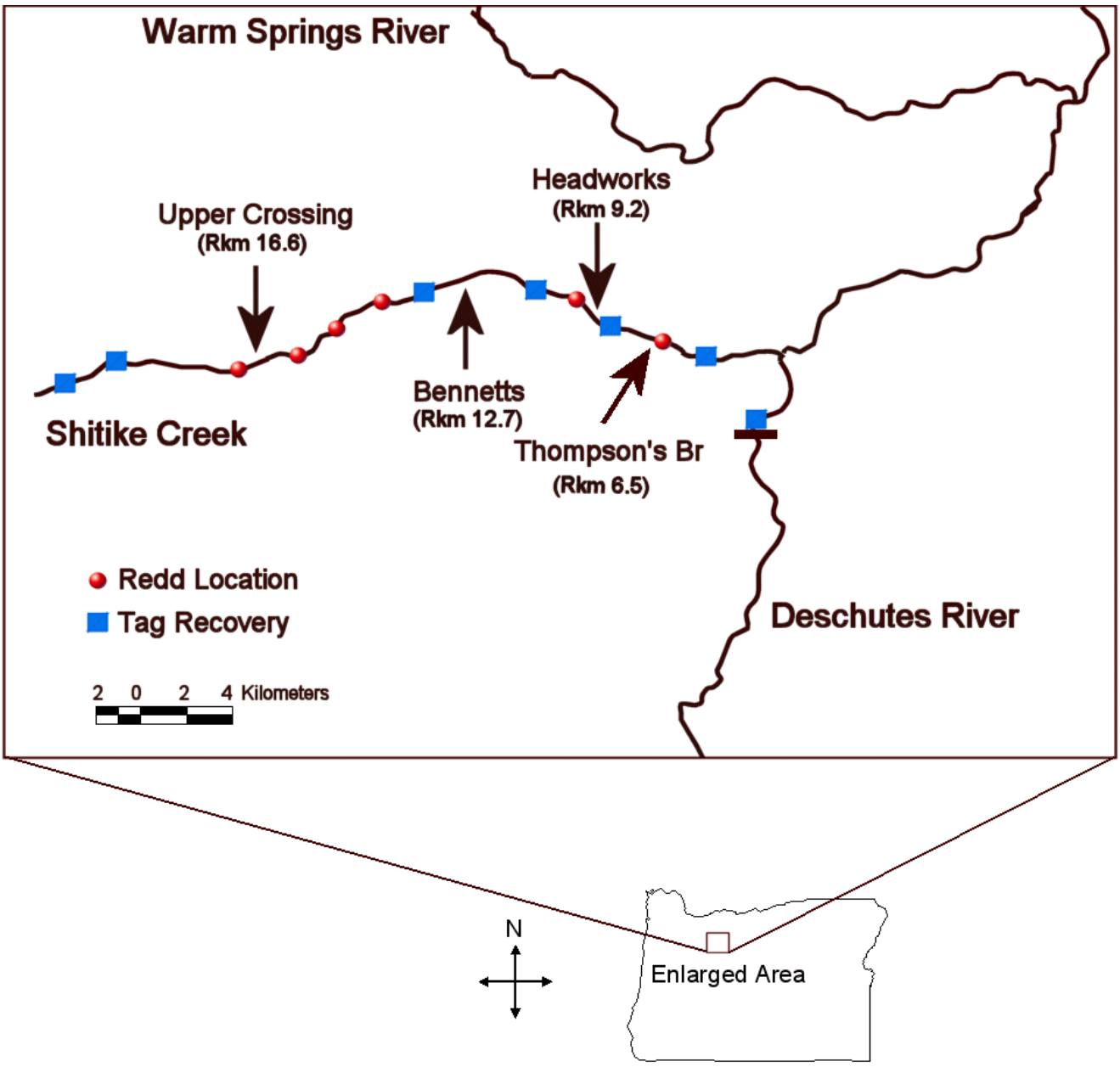

Figure 7. Redd locations of radio-tagged spring Chinook salmon and radio-transmitter recovery locations. Some radio-transmitters fell off of the fish prior to spawning/mortality. Arrows denote outplanting locations.

Reproductive Success

No adult spring Chinook were sampled at the adult weir in 2002. Adult spring Chinook (non-adipose clipped) were seen above the weir during snorkel surveys in July and August, indicating that fish moved upstream of the adult weir either when the weir was flooded out or during days when pickets were removed and the weir was not operated. The number of non-outplanted spring Chinook that migrated into Shitike Creek in 2002 is not known. To get a rough estimate of the number of spring Chinook in Shitike Creek, fish per redd numbers from the Warm Springs River were used. Redd surveys and counts of spring Chinook salmon passed above the barrier dam at the hatchery (Rkm 16) on the Warm Springs River produced an estimate of 6.5 spring Chinook per redd in 2002 (CTWSRO unpublished data). The high fish per redd estimate indicates a high pre-spawning mortality. The hatchery broodstock population suffered a high pre-spawning mortality due to the *Ich* parasite and it is likely that the pre-spawning mortality in the wild population was also due to *Ich*. Redd surveys conducted by the CTWSRO in Shitike Creek counted 28 spring Chinook redds in 2002. Assuming the fish per redd numbers for Shitike Creek are similar to the Warm Springs River, an estimated 182 spring Chinook were in Shitike Creek. Subtracting the 83 outplanted spring Chinook from the total produces an estimate of 99 non-outplanted spring Chinook migrating up Shitike Creek (Figure 8). Since genetic samples were not available from non-outplanted spring Chinook, a comparison of reproductive success between outplanted and non-outplanted fish will not be possible for the 2002 brood year. Genetic samples from the outplanted fish were sent to the USFWS Conservation Genetics Lab in Abernathy, WA to provide baseline information on the genetic makeup of the outplanted fish. Genetic sampling of progeny of the 2002 brood in Shitike Creek during 2003 and 2004 will provide an indicator of whether or not fish outplanted in 2002 contributed to the juvenile spring Chinook population. The study design has been modified to account for the problems in data collection at the adult weir (see the following section, Work Plan 2003).

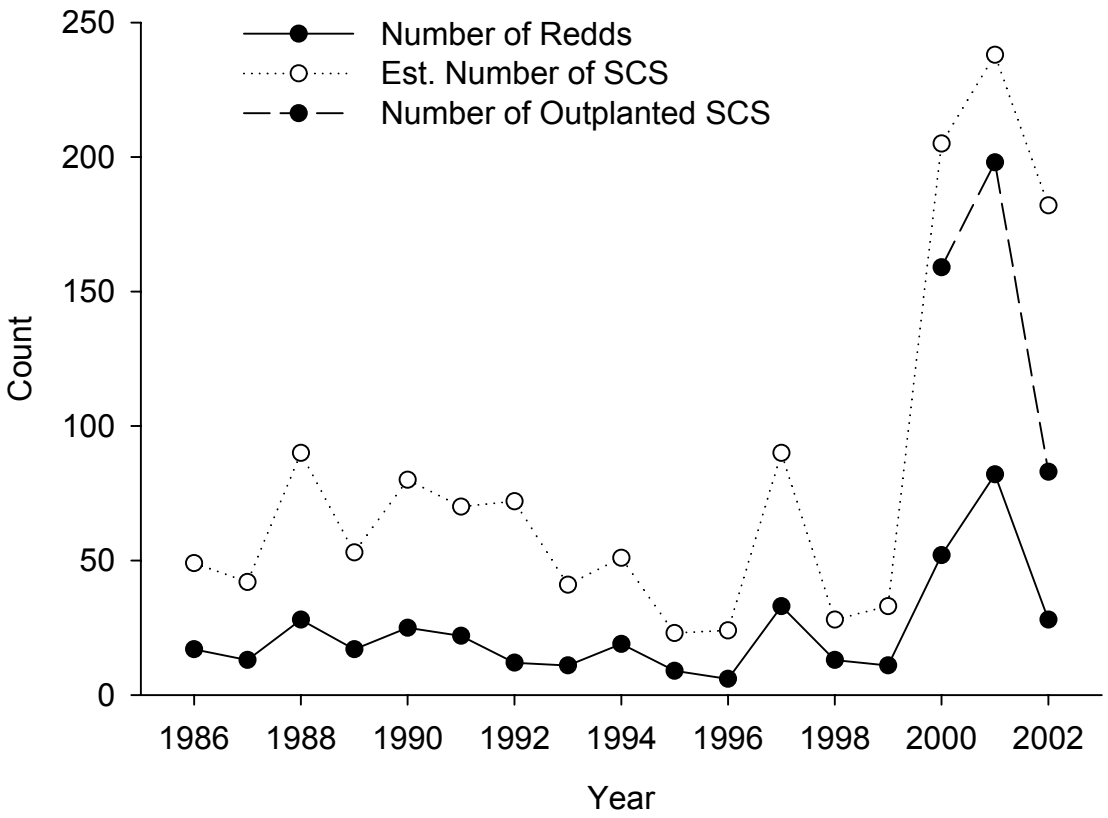

Figure 8. Number of redds, an estimate of the number of spring Chinook salmon (SCS), and the number of outplanted SCS in Shitike Creek by year. The number of SCS was estimated by multiplying the number of redds in a year by the number of fish per redd calculated for the Warm Springs River for the corresponding year (CTWSRO unpublished data).

Acknowledgements

We would like to thank the field staff of the Confederated Tribes of the Warm Springs Reservation of Oregon, particularly Art Mitchell, Dave Lucei, and Leilani Polk for their help in data collection and field support during the outplanting program. We would also like to thank Warm Springs Forest Products Industries for allowing access to their property and use of their power source for the fixed-site station. Finally, we thank Mike Paiya, Mavis Shaw, Kevin Blueback, Randy Boise, and Dan Magneson of Warm Springs National Fish Hatchery for collecting the adult fish for the outplanting program and assisting with data collection and study design.

Work Plan 2003

Adult Radio-Telemetry

Outplanting of hatchery fish into Shitike Creek is expected to continue in 2003. Assuming that disease problems and pre-spawning mortality are not as severe as in 2002, the goal is to outplant 200 adult hatchery spring Chinook salmon into Shitike Creek. A total of 14 radio-transmitters were either recovered off of outplanted fish or not used in 2002. It is expected that funds will be available to buy 21 new radio-transmitters making a total of 35 available for attachment in 2003. Attachment of the radio-transmitters is expected to be similar to the previous year. Assuming that six loads of fish will be outplanted, five to six fish will be radio-tagged per load. The male to female tagging ratio will again be skewed towards females in order to provide more opportunity to locate redds and observe spawning behavior.

Telemetry tracking equipment and personnel will be increased in order to spend more time on the stream observing fish. A fixed-site telemetry station will be set up near the mouth of Shitike Creek (Rkm 0.5). Another fixed-site station will be set up in the upper basin, most likely near Upper Crossing (Rkm 16.5). Two mobile telemetry receivers will be available for tracking. Fish will be tracked on a daily basis. In 2003, at least one group of outplants will be tracked immediately after release in order to determine behavior/recovery time from transportation.

Objective: Assess the distribution and behavior of outplanted spring Chinook salmon in Shitike Creek.

Task 1.1. Tag hatchery spring Chinook salmon prior to outplanting with colored floy tags and/or radio-transmitters.

Activity: Externally radio-tag a subsample of outplanted hatchery spring Chinook salmon. Transmitters will be attached at the base of the dorsal fin using wire-gauge needles and colored disk tags as backing. A total of 35 radio-transmitters will be externally attached. Six to eight loads of fish (25-30 fish/load) will be outplanted into Shitike Creek. Four to six fish will be radio-tagged per load. A stratified random selection of fish will be tagged with fish stratified by sex. Tagging will be weighted towards females in order to increase the probability of finding radio-tagged fish on redds.

Schedule: Mid-August to Mid-September. Tagging will take place on all outplant days.
Personnel: 2 USFWS, 1 CTWSRO

Task 1.2. Determine the distribution of radio-tagged spring Chinook salmon in Shitike Creek.

Activity: Track radio-tagged fish using mobile-tracking equipment and fixed-site telemetry stations. Radio-tagged fish will be tracked upon release into Shitike Creek using a portable Lotek receiver and YAGI antenna. Once a fish is located, the location will be recorded using a GPS system and marked on a map. Fixed-site stations will be located near the mouth of Shitike Creek (Rkm 0.5) and near Upper Crossing (Rkm 16.5). Radio-tagged fish will be tracked until initiation of spawning activity. When fish move onto redds, the redds will be flagged and recorded on a map.

Schedule: Late August through September, 3-4 days/week. Radio tracking will take place on a weekly basis as fish are outplanted and continue through spawning.
Personnel: 1 USFWS, 1 CTWSRO

Task 1.3. Determine the mate choice and redd characteristics of outplanted spring Chinook salmon.

Activity: When spawning fish are found either through radio-telemetry or spawning surveys, the origin of the mate will be recorded as either outplanted or wild. If carcasses of fish are found, the carcasses will be examined in order to estimate spawning success based on gamete retention. Once redds have been abandoned the redd characteristics (length, width, gravel size, water velocity) will be measured and recorded. The habitat in the areas surrounding the redds will also be characterized to determine if outplanted and natural origin fish spawn in similar habitats.

Schedule: Late August through September, 2 days per week.
Personnel: 1 USFWS, 1 CTWSRO

Reproductive Success

The original objective of the reproductive success monitoring program was to sample 100% of the outplanted spring Chinook salmon and 100% of the natural-origin spring Chinook salmon in Shitike Creek. While 100% of the outplanted population was sampled in 2002, high-flows and five-day per week operation of the weir resulted in no tissue samples for the natural-origin population. Due to concerns about the weir operation on listed bull trout populations and the logistical problems of operating the weir seven days per

week the Service and the CTWSRO have modified the sampling design for 2003. The weir will be moved to a location just downstream of the 2002 location. This new location is expected to reduce the risk of damage to the weir from high flows. In addition, after consultation with the USFWS Conservation Genetics Lab in Abernathy, WA, it was decided that a sampling rate of less than 100% would still allow for a comparison of reproductive success. While sampling less than 100% of the population will not allow for a determination of exact parentage of juveniles, a comparison of the relative reproductive success can be made if the proportion of the adult population that was sampled is known (William Ardren USFWS pers. comm.). For 2003, a sampling goal of at least 50% of the natural-origin population has been set. The weir will only be operated from early Monday morning to late Friday evening. During the weekends, pickets in the weir will be removed to allow fish to migrate up Shitike Creek unimpeded. A mark-"re-sight" method will be used to estimate the proportion of the natural-origin population that was sampled at the weir. Fish sampled at the weir will be marked with a floy-tag and opercle punched on the left side of the fish. Outplanted fish will be floy-tagged on the right side. Re-sight surveys will be conducted by snorkeling the stream and counting the number of marked and unmarked spring Chinook. The proportion of marked to unmarked fish or carcasses will be used to estimate the total population.

Genetic sampling will begin on progeny from the 2002 outplant brood. A minimum of 1000 fin clips from progeny of the 2002 brood will be collected from the rotary screw trap near the mouth of Shitike Creek and during in-stream sampling. Based on screw trap data from 2001 and 2002 it appears that newly emergent age 0+ spring Chinook are caught as early as mid-May. Genetic sampling for age 0+ fish will begin in the spring of 2003. Sampling will continue for age 0+ during the fall trapping period (October-December) and fin-clips will also be taken from age 1+ smolts in the spring of 2004. Sampling at the screw trap will be done proportionately throughout the migration. In-stream sampling will take place during mark-resight snorkel surveys conducted as part of the Shitike Creek juvenile fish interactions assessment. In-stream sampling will occur in randomly selected reaches of the stream.

Objective: Estimate the reproductive success of natural-origin and outplanted hatchery-origin spring Chinook salmon in Shitike Creek using genetic pedigree analyses.

Task 1.1. Collect fin-clips for genetic analysis from at least 50% of the natural-origin and 100% of the outplanted hatchery-origin spring Chinook salmon in Shitike Creek.

Activity: Install and operate an adult weir near the mouth of Shitike Creek. The adult weir will be installed and operated as soon as stream conditions permit, at least May through August. The goal is

to sample at least 50% of the naturally migrating adult spring Chinook. Length measurements, scale samples, and fin clips will be collected from all adult spring Chinook passing through the weir. Fin-clips, approximately a 1 cm^2 area, will be taken from the caudal or pectoral fin and preserved in 100% ethanol. Fish will then be tagged with a numbered floy tag and an opercle punch. Fish will then be passed upstream. Fin-clips will also be collected from carcasses encountered during redd surveys if it can be determined that the fish were not previously sampled at the weir (based on opercle punch/floy-tag). A mark-resight snorkel survey will be done in mid-August to estimate the total number of naturally migrating spring Chinook in the creek. Outplanted hatchery-origin spring Chinook will be sampled at the hatchery as the fish are sorted for outplanting. Data collection for outplanted fish will be the same as for natural-origin fish. Data collection is expected to continue for three complete brood cycles.

Schedule: The adult weir will be operated five days per week from May through September through 2006 (potentially longer based on update of Operational Plan in 2006, three complete brood cycles would be through 2008).
Personnel: 2 CTWSRO

Task 1.2. Collect fin-clips from a minimum 1,000 juvenile spring Chinook outmigrants per brood year.

Activity: Juvenile spring Chinook outmigrants will be sampled at a rotary screw trap located near the mouth of Shitike Creek and in-stream during mark-resight snorkel surveys associated with the Shitike Creek juvenile fish microhabitat assessment (see Addendum A). Fin-clips will be collected from subyearling and yearlings proportionately throughout the outmigration period. Scale samples and lengths will be used to determine brood year. Sampling for subyearlings from the 2002 brood will begin in May. Sampling of subyearlings will continue through the fall trapping period. In 2004, age 1+ and age 0+ will be sampled. At the screw trap, fin-clips will be collected on days when fish are marked for trap efficiency estimates. Fin-clips will be stored in Nalgene bottles filled with 100% ethanol. Samples will be stratified by day with all fin-clips from a particular day placed in the same bottle. For in-stream sampling, lengths and weights will be collected from each fish and the fin-clips will be stored in individual containers.

Schedule: May-June, October-November (screw trap)
June-August (in-stream sampling)
Personnel: 2 CTWSRO, 2USFWS

Task 1.3. Determine genotypes of all adult spring Chinook upstream of the weir and a subsample of juveniles outmigrating from Shitike Creek.

Activity: Determine multi-locus genotypes at 10-15 micro-satellite nuclear DNA loci for each adult spring Chinook salmon upstream of the weir. Obtain similar data for a minimum of 1,000 progeny of each brood year and determine the parent of each juvenile fish via DNA assignment tests and pedigree analyses. Continue for three complete brood cycles to evaluate the return rate of the progeny of natural-origin and outplanted hatchery-origin adults.

Schedule: Completed by 2006
Personnel: USFWS Conservation Genetics Lab, Abernathy WA

Sampling Schedule

Objective 1

Adult Distribution/Behavior (2003)

	Aug. 17-23	Aug. 24-30	Aug. 31-Sept. 6	Sept. 7-13	Sept.14-20	Sept. 21-27
Tagging-Personnel-	1 day 3 people	1 day 3 people	1 day 3 people			
Telemetry-Personnel-	2 days 2 people	2 days 2 people	2 days 2 people	2 days 2 people	2 days 2 people	
Surveys-Personnel-	1 day 3-4 people	1 day 3-4 people	1 day 3-4 people	1 day 3-4 people	1 day 3-4 people	
Redd meas.-Personnel-					2 days 2 people	2 days 2 people

Objective 2

Reproductive Success

	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Adult weir							
Hatchery outplants							
Juvenile Outmigrants							
Subyearlings in Shitike Cr.							

References

Brun, C. and R. Dodson, 2001. Bull trout distribution and abundance in the waters on and bordering the Warm Springs Reservation. 2001 Annual Report. Confederated Tribes of the Warm Springs Reservation, Oregon. Prepared for the Bonneville Power Administration Project Number 1994-054.

Burgert, R., C. Busack, G. Mendel, L. Ross, K. Petersen, D. Marbach and J. Dedloff. 1991. Lower Snake River compensation plan Tucannon River spring Chinook salmon hatchery evaluation program, 1990 Annual Report. Washington Department of Fisheries. 81 pp.

Dambacher, J. M. 2002. Project Report: Relative abundance of juvenile Chinook salmon in Shitike Creek of the Confederated Tribes of the Warm Springs Reservation, Oregon. Oregon Department of Fish and Wildlife, Corvallis OR.

Lindsay, R. B., B. C. Jonasson, R. K. Schroeder, and B. C. Cates, 1989. Spring Chinook salmon in the Deschutes River, Oregon. Oregon Department of Fish and Wildlife, Information Report 89-4, Portland.

Nigro, A. A. and D. L. Ward, 1985. Annual Progress Report: Evaluation of lower Umatilla River channel modifications below Three Mile Dam, 1984. Bonneville Power Administration, Portland, OR.

Olson, D. E. and B. Spateholts, 2001. Hatcheries harvest and wild fish . . . an integrated program at the Warm Springs National Fish Hatchery, Oregon. U.S. Fish and Wildlife Service, Vancouver, Washington. Presented at the 52nd Annual Pacific Northwest Fish Culture Conference Hosted by the Oregon Department of Fish and Wildlife, Portland, OR.

Pearsons, T. N., G. A. McMichael, S. W. Martin, E. L. Bartrand, J. A. Long, and S. A. Leader.1996. Yakima species interactions studies annual report 1994. Project Number 89-105 Bonneville Power Administration, Portland, OR.

Quinn, T. P. 1997. Homing, straying, and colonization *in* W. Stewart Grant, editor. Genetic effects of straying of non-native hatchery fish into natural populations: proceedings of the workshop. U.S. Dep. Commerce, NOAA Tech Memo. NMFS-NWFSC-30, 130p.

Reisenbichler, R. R. and S. P. Rubin. 1999. Genetic changes from artificial propagation of Pacific salmon affect the productivity and viability of supplemented populations. ICES Journal of Marine Science 56: 459-466.

Underwood, K. D., S. W. Martin, M. L. Schuck, and A. T. Scholz. 1995. Investigations of bull trout (*Salvelinus confluentus*), steelhead trout (*Oncorhynchus mykiss*), and spring Chinook salmon (*O. tshawytscha*) interactions in southeast Washington streams. Project Number 90-053 Bonneville Power Administration, Portland, OR.

Warm Springs National Fish Hatchery Operational Plan and Implementation Plan 2002-2006. United States Fish and Wildlife Service and the Confederated Tribes of the Warm Springs Reservation of Oregon.

Zar, J. H. 1984. Biostatistical Analysis, 2nd edition. Prentice Hall, Englewood Cliffs, New Jersey.

Addendum A

Microhabitat Selection of Juvenile Steelhead Trout, Juvenile Chinook Salmon, and Bull Trout Within Shitike Creek, OR at Varying Fish Densities.

Introduction

The Service and the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO) received funding in 2002 to investigate potential ecological interactions between hatchery and wild fish (FONS Project Number 1999-010). As part of this evaluation, the Service and the CTWSRO are planning to implement a survey to evaluate microhabitat use of juvenile spring Chinook salmon, juvenile steelhead trout, and bull trout. The results of the evaluation would be used by National Fish Hatchery personnel, and managers of natural resources, to mitigate and reduce ecological interactions between hatchery and wild fish. The following project objectives are proposed for fiscal year 2003.

Objectives:

1) Identify microhabitat selection (depth, water velocity, species association, cover use, temperature) juvenile Chinook salmon, juvenile steelhead trout and Bull trout within Shitike Creek at varying densities (fish/m^3).

2) Determine if there is a relationship between microhabitat selection and fish density in slow and fast-water channel units.

Potential Management Action: Adjust or manipulate the number or location of adult Chinook outplantings to maximize number of Chinook produced but minimize any density effects on microhabitat selection of juvenile steelhead trout or bull trout.

Input from project cooperators, the CTWSRO Fish and Wildlife Committee and biometric specialists may slightly alter or change the methodologies or actions proposed within this document.

Objective 1: Identify microhabitat selection of juvenile Chinook salmon, juvenile steelhead trout and Bull trout within Shitike Creek at varying densities.

Methods

To identify microhabitat selection of juvenile Chinook salmon, juvenile steelhead trout (either progeny of steelhead or resident rainbow trout), and bull trout within Shitike Creek, a microhabitat survey will be instituted during summer 2003. To reduce handling of fish and crew effort, snorkeling techniques will be used to collect microhabitat data. Additionally, an abundance estimate of

juvenile steelhead trout, juvenile Chinook salmon and Bull Trout will be performed in every habitat unit where microhabitat data is collected.

The microhabitat survey will consist of three or four person crew performing visual observation and enumeration of juvenile Chinook salmon, juvenile steelhead trout and Bull trout in slow and fast-water channel units. Every 3rd juvenile steelhead trout and juvenile Chinook salmon encountered by a snorkeler will be selected for collection of microhabitat data. Only fish not disturbed by the snorkeler will be selected for collection of microhabitat data. The proposed microhabitat survey will measure and institute similar variables measured by Underwood et al. (1995) to determine microhabitat preference (Table 1). Snorkelers will collect a minimum of 10 microhabitat observations on juvenile steelhead trout and juvenile Chinook salmon within a fast or slow-water channel unit.

After collection of microhabitat data within a channel unit, a bounded count will be performed by snorkelers using methodologies similar to a previous abundance survey conducted by Dambacher (2001). In this previous juvenile salmonid abundance survey (Dambacher 2001), a number of fast and slow water habitats were identified, snorkeled, and abundance estimates generated for each sampled habitat unit throughout the distribution of juvenile Chinook salmon in Shitike Creek (Table 2 and Figure 1). Based on results of the 2001 abundance survey, a large amount of the juvenile Chinook and juvenile steelhead trout populations occur in slow-water habitat rather than fast-water habitat (Figures 2 and 3). A proposed sampling fraction of slow and fast-water channel units for the proposed microhabitat survey is outlined in Table 2.

Table 1. Microhabitat variables (Underwood et al. 1995) to be collected on randomly selected juvenile steelhead trout, juvenile Chinook salmon, and Bull Trout within Shitike Creek, OR. Variables measured relate to the selected fish or the immediate area the fish inhabits at the time of observation.

Variable	Unit or Category(s)	Description
Species	SST SCS BLT	Steelhead or Rainbow Trout (*Oncorhynchus mykiss*) Spring Chinook Salmon Bull Trout
Age	0+ Post age 0+	SCS – Age 0+ ≤ 115 mm SST – Age 0+ ≤ 90 mm Post age 0+ >90 mm BLT – Age 0+ ≤ 90 mm Post age 0+ >90 mm
Distance from Streambed	Meters (0.1)	Distance from streambed at the time of snorkel observation.
Most Prevalent Substrate Type	Silt or Fines (<2.0 mm) Small Gravel (2.0 – 15 mm) Large Gravel (>15mm – 60mm) Small Cobble (60-130 mm) Large Cobble (120-250 mm) Boulder (>250 mm)NA	From Platts et al. (1984). Estimated from snorkel observation. The snorkel observation crew will be calibrated at start of microhabitat survey on their identification and classification of these substrate categories
Total Depth	Meters (0.1)	Measured at point of fish location from streambed to surface of water.
Nearest Cover Type	Boulders Undercut Banks Turbulence (Bubble Curtain) Overhead Vegetation Small Woody Debris Large Wood Debris	From Wesche et al. (1987). Cover type will be determined by snorkel observation of fish for a time of at least one minute.
Distance to Nearest Cover Type	Meters (0.1)	Visually estimated from snorkel observation.
Nearest fish Species	SST SCS BLT Other	Steelhead or Rainbow trout Spring Chinook Salmon Bull Trout Other species present within Shitike Creek
Distance of nearest fish Species	Meters (0.1)	Visually estimated from snorkel observation.
Grouped or Ungrouped	G or U	In a group of other fish (within 30cm) or not grouped with other fish (> 30cm away from another fish. If grouped with other fish an estimate of the number of fish will be made by the snorkeler and the species composition of that group.
Water Velocity	Meters per second (MPS)	Measured using Global Water Velocimeter at end of snorkel observation. In an effort not to disturb observed fish, a marker will be placed below the fish and velocity will be measured at the end of snorkel observation and at the conclusion of microhabitat survey in the selected unit.

Table 2. Total fast water (FW) and slow water (SW) channel units in Shitike Creek, OR during 2001 juvenile abundance survey for reaches 1-5 (Dambacher 2001). Percent composition of each channel unit, for each reach is provided in parentheses. The number of units in each reach for 2001 sampling and 2003 proposed sampling scenarios is also provided.

Habitat			Total habitat		2001 Sampling (variable %)	Previously Proposed 2003 SW=15%	Currently proposed 2003 sampling Reaches 1, 3†, 5 SW=15% FW=10%
Reach	type	N	length (m)	Area (m^2)	n	n	N
1	FW	92	7,429 (74%)	110,695 (78%)	9		9
	SW	81	2,642 (26%)	30,940 (22%)	16	13	13
2	FW	23	2,420 (90%)	30,949 (90%)	2		
	SW	9	277 (10%)	3,297 (10%)	9	2	
3†	FW	75	6,147 (78%)	63,792 (78%)	10		10†
	SW	54	1,756 (22%)	17,666 (22%)	11	9	9†
4	FW	102	14,390 (91%)	162,648 (91%)	13		
	SW	45	1,376 (9%)	15,410 (9%)	8	7	
5	FW	32	2,976 (64%)	35,088 (65%)	4		4
	SW	37	1,669 (36%)	19,068 (35%)	8	6	6
Total	FW	324	33,362 (81%)	403,172 (82%)	38		23
Total	SW	226	7,720 (19%)	86,381 (18%)	52	37	28
Overall		550	41,082	489,553	90	37	51
Estimated Time for Survey - 1 Person , 10 hrs/day					N/A	30 days*	40 days*
Estimated Time for Survey - 2 People, 10 hrs/day					N/A	15 days*	20 days*
Estimated Time for Survey - 3 People, 10 hrs/day					N/A	10 days*	14 days*

* Assumes 4 hours for microhabitat sampling, 2 hours travel time, and 1 hour for bounded counts, and 1 hour hike time for each slow water habitat unit. These estimates do not include travel time for USFWS personnel to and from Vancouver, WA.

† Reach 3 would only be sampled when reaches 1 and 5 have been completed, and if time permits sampling

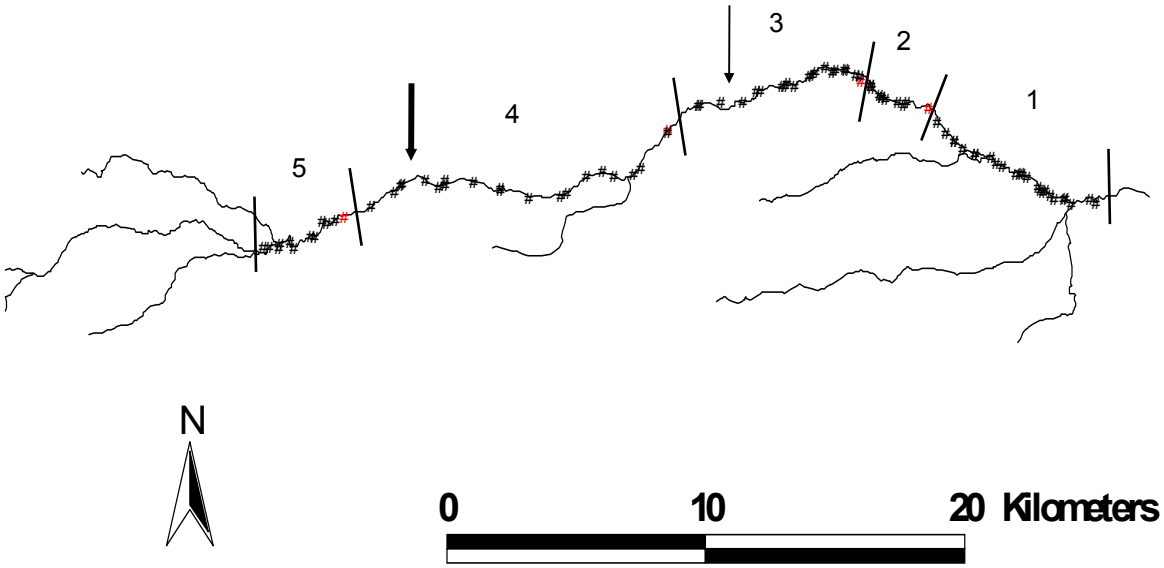

Fig. 1. Shitike Creek basin—tributary of the Deschutes River—in the Confederated Tribes of the Warm Springs Reservation, Oregon. Number and boundaries of each reach used in juvenile Chinook salmon abundance surveys (Dambacher 2001) are denoted. Reach 1 includes the area from the Community Center to Thompson's Bridge. Reach 2 includes Thompson's Bridge to Headworks. Reach 3 includes the area from Headworks to Bennetts. Reach 4 includes the area known as Upper Crossing. Reach 5 is the area from Peters Pasture upstream. The thin arrow denotes observed downstream limit of juvenile bull trout at "Upper Crossing" from Electrofishing conducted by CTWSRO and ODFW personnel in 2000. The thick arrow denotes lower boundary of regular bull trout observations in snorkel-dive counts during 2001. Reproduced from Dambacher (2001).

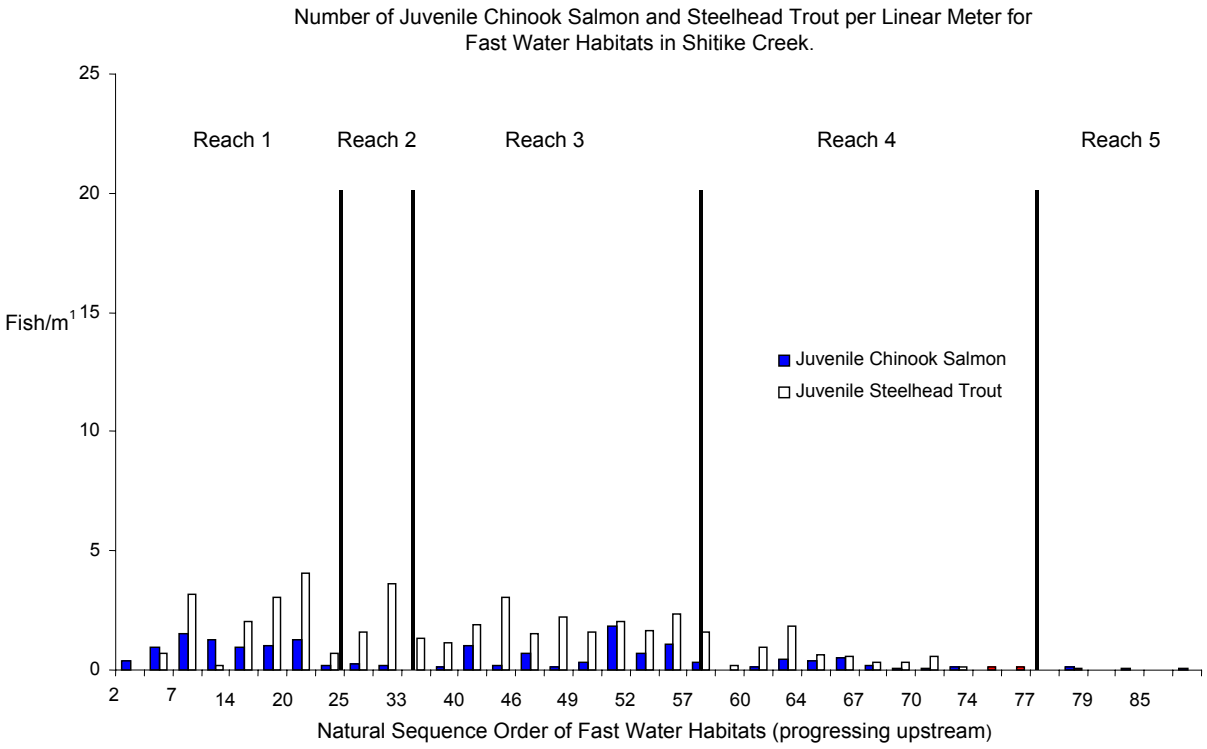

Figure 2. Number of juvenile Chinook salmon and steelhead trout per linear meter of fast water habitat units in Shitike Creek, OR 2001. Reach 1 includes the area from the Community Center to Thompson's Bridge. Reach 2 includes Thompson's Bridge to Headworks. Reach 3 includes the area from Headworks to Bennetts. Reach 4 includes the area known as Upper Crossing. Reach 5 is the area from Peters Pasture upstream. Data presented is from Dambacher (2001).

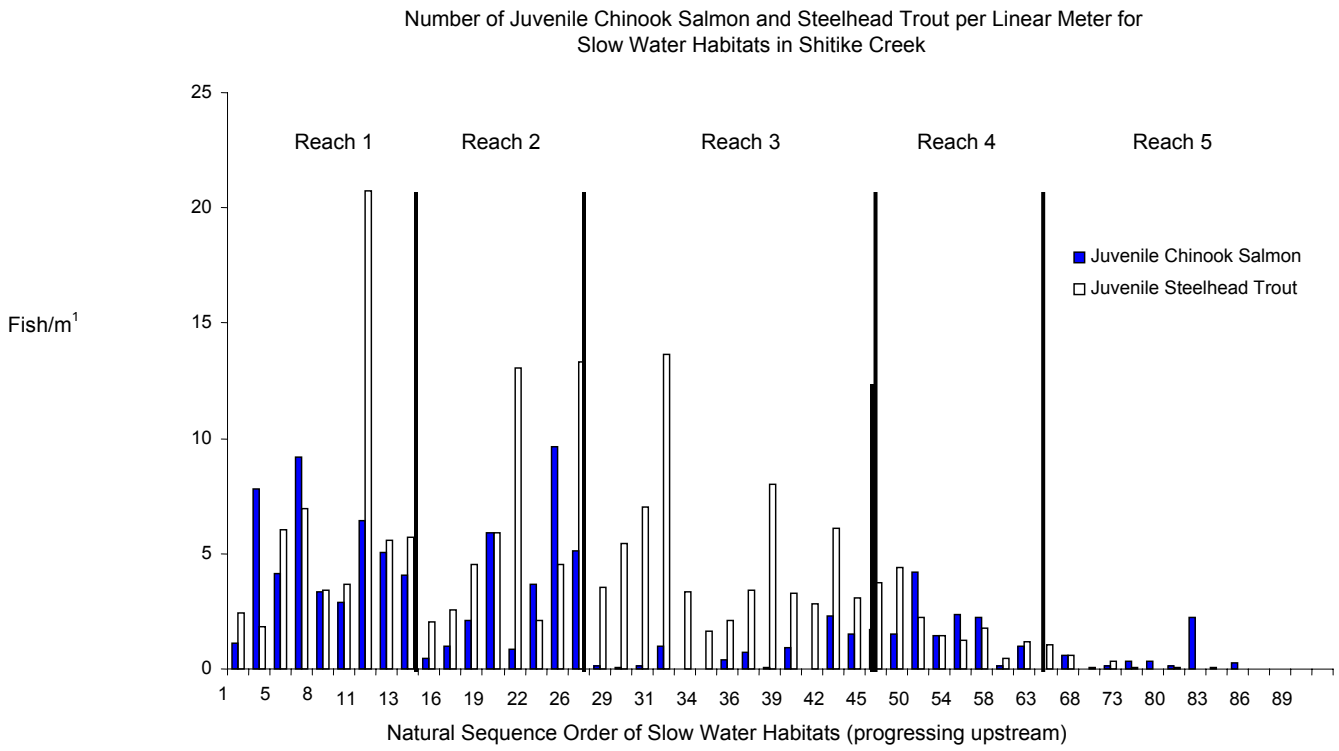

Figure 3. Number of juvenile Chinook salmon and steelhead trout per linear meter of slow water habitat units in Shitike Creek, OR 2001. Reach 1 includes the area from the Community Center to Thompson's Bridge. Reach 2 includes Thompson's Bridge to Headworks. Reach 3 includes the area from Headworks to Bennetts. Reach 4 includes the area known as Upper Crossing. Reach 5 is the area from Peters Pasture upstream. Data presented is from Dambacher (2001).

A change to the past survey abundance methodology used in Shitike Creek by Dambacher (2001) would involve a modification to the bounded counts estimator (Robson and Whitlock 1954; Routledge 1982) used to estimate juvenile fish abundance when performing snorkel counts. The bounded counts estimator is

$$\hat{Y} = X_m + (X_m - X_{m-1})$$

where,

$\hat{Y}$ = abundance estimate for unit

X_m = highest count

X_{m-1} = next highest count

Dambacher (2001) found that in most units sampled for juvenile abundance, only counts made by divers during the first 3 of 4 passes were used in the bounded counts estimator therefore, only 3 passes will be required for snorkelers during the bounded counts to be performed in fast and slow-water units within Shitike Creek during 2003.

Traditionally, validation of a bounded count estimate on a channel unit is conducted using multiple pass electrofishing (Hankin and Reeves 1988). In an effort to calibrate snorkel counts, reduce stress on juvenile fish and conserve man-hours, a new snorkel count calibration method will be instituted using a mark-resight methodology (Table 3). The mark-resight estimate calculated from that snorkel count will be considered the "true" number of juvenile steelhead trout and Chinook salmon within the slow-water unit. A correction factor based on a linear regression of the "true" number against the estimated number from the 3 pass bounded count will be calculated and applied to units where the mark-resight methodology was not performed. Due to handling concerns for Bull Trout and the pending completion of an intra-Service Section 7 Consultation, only 3 slow-water channel units will be selected for mark-resight calibration. The selected units will occur below the initial juvenile Bull Trout snorkel observation within Shitike Creek during the 2001 (Figure 1).

When microhabitat observation and bounded counts have been completed in a slow water unit, the total length of the unit down the thalweg and three width measurements systematically spaced through the unit will be recorded. Maximum depth at each width measurement will also be noted. Unit dimensions (length, average width, and average depth) will be used to calculate total density within a habitat unit (estimated number of fish/m^3).

Table 3. Proposed mark-resight methodology to be conducted on three (3) randomly selected slow water channel units within Shitike Creek, OR.

Step Number	Procedure	Description
1	Block net unit on up and downstream sections.	Will ensure no immigration or emigration from selected slow-water unit during marking procedure or after marked fish are released back into unit
2	Multiple seine pulls through unit.	At least two pulls of a seine will be attempted in each selected unit to maximize catch for marking.
3	Collected fish will be anesthetized; fork length (mm) and weight (g) of individual fish will be recorded.	Collected fish will be held in perforated buckets within Shitike Creek to maintain adequate flow. Water temperature will also be monitored. Fish will not be marked, measured, or captured in water temperatures that are in excess of 18C, or on days that water temperature could exceed 18C for more than a 2 hour period.
4	Fish will be marked with a solution of Bismarck Brown Y and released.	After fish are anesthetized, measured, and weighed they will be placed in a tub of stream water and Bismarck Brown Y solution. Stream water and Bismarck Brown Y will be mixed to form a 0.007% solution. Fish will placed in the solution for 10 minutes then released back into the slow-water unit. The proposed concentration of Bismarck Brown Y solution and immersion time will illicit a mark retention of approximately 2 days, dependent on water quality. Further trials of mark retention and underwater observation of marked fish is planned at Eagle Creek NFH during late June 2003 and will involve both USFWS and CTWSRO personnel.
5	A three (3) hour block of time will allow marked fish to acclimate.	To meet assumptions of a mark-resight procedure, marked fish must exhibit normal behavior and mix with unmarked fish within the unit.
6	Mark-resight snorkel count will be performed.	Three (3) snorkel observers will conduct an enumeration of marked and unmarked individuals within the slow-water unit to calculate the “true” number of juvenile steelhead trout and Chinook salmon within the unit.

Objective 2: Determine if there is a relationship between microhabitat selection and fish density in slow and fast-water channel units.

Several statistical analyses will be performed to determine relationships between microhabitat preference, fish density and water temperature (Table 4). Statistical analyses are identified in this document but have not been scrutinized and approved by Service Biometric specialists. When statistical analyses have been approved by Service Biometric specialists, project cooperators will be immediately informed and a final document will be provide to project cooperators, the CTWSRO Fish and Wildlife Committee and other interested parties.

Table 4. Hypotheses to be tested, statistical test to be used and alpha level

Null Hypothesis	Test	Alpha level
Microhabitat preference (velocity, depth, distance to cover etc.) is the same between reaches 1, 3, and 5 for post age 0+ juvenile steelhead trout in fast-water units. A minimum of 10 microhabitat observations per channel unit for juvenile chinook salmon and juvenile steelhead trout combined. Reach 1= 9 fast-water Reach 3 = 10 fast-water Reach 5 = 4 fast-water	ANOVA	α = 0.05
Microhabitat preference (velocity, depth, distance to cover etc.) is the same between reaches 1, 3, and 5 for post age 0+ juvenile steelhead trout in slow-water units. A minimum of 10 microhabitat observations per channel unit for juvenile chinook salmon and juvenile steelhead trout combined. Reach 1= 13 slow-water channel units Reach 3 = 9 slow-water channel units Reach 5 = 6 slow-water channel units	ANOVA	α = 0.05
Microhabitat preference (velocity, depth, distance to cover etc.) is the same between reaches 1, 3, and 5 for post age 0+ juvenile Chinook in fast-water units. A minimum of 10 microhabitat observations per channel unit for juvenile chinook salmon and juvenile steelhead trout combined. Reach 1= 9 fast-water Reach 3 = 10 fast-water Reach 5 = 4 fast-water	ANOVA	α = 0.05
Microhabitat preference (velocity, depth, distance to cover etc.) is the same between reaches 1, 3, and 5 for post age 0+ juvenile Chinook in slow-water units. A minimum of 10 microhabitat observations per channel unit for juvenile chinook salmon and juvenile steelhead trout combined. Reach 1= 13 slow-water channel units Reach 3 = 9 slow-water channel units Reach 5 = 6 slow-water channel units	ANOVA	α = 0.05
Microhabitat (velocity, depth, distance to cover etc.) of juvenile steelhead trout is independent of overall fish density and chinook density within each reach. (slope = 0) A minimum of 10 microhabitat observations per channel unit for juvenile chinook salmon and juvenile steelhead trout combined. Reach 1= 13 slow-water channel units Reach 3 = 9 slow-water channel units Reach 5 = 6 slow-water channel units Reach 1= 9 fast-water Reach 3 = 10 fast-water Reach 5 = 4 fast-water	Regression Analysis	α = 0.05

Proposed Sampling Schedule and Completion Timeline

Objective	Activity	FY 2003					
		July 7-13	July 14-20	July 21-27	July 28-Aug 3	Aug 4 – Aug 9	Aug 10 – Jan 31, 2004
Identify microhabitat selection of juvenile Chinook salmon, juvenile steelhead trout and Bull trout within Shitike Creek at varying fish densities.	Selection of fast and slow-water units for microhabitat sampling. Possible start of microhabitat surveys.	July 7-8					
Identify microhabitat selection of juvenile Chinook salmon, juvenile steelhead trout and Bull trout within Shitike Creek at varying dish densities.	Possible start of microhabitat surveys.	July 9-11					
Identify microhabitat selection of juvenile Chinook salmon, juvenile steelhead trout and Bull trout within Shitike Creek at varying fish densities.	Microhabitat surveys in slow and fast-water units.		All Week	All Week	All Week	Partial Week	
Determine if there is a relationship between microhabitat selection and fish density in slow and fast-water channel units.							In addition to other assigned duties.

Literature Cited

Dambacher, J.M. 2002. Project report: relative abundance of juvenile Chinook salmon in Shitike Creek, of the Confederated Tribes of the Warm Springs Reservation, Oregon. Oregon Department of Fish and Wildlife, Corvallis Research Lab, Corvallis, OR. 12 pp.

Hankin, D.G., and G.H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences 45: 834-844.

Robson, D.S. and J.H. Whitlock. 1964. Estimation of a truncation point. Biometrika 51: 33-39.

Routledge, R.D. 1982. The method of bounded counts: when does it work? Journal of Wildlife Management 46: 757-761.

Underwood, K. D., S. W. Martin, M. L. Schuck, and A. T. Scholz. 1995. Investigations of bull trout (*Salvelinus confluentus*), steelhead trout (*Oncorhynchus mykiss*), and spring Chinook salmon (*O. tshawytscha*) interactions in southeast Washington streams. Project Number 90-053 Bonneville Power Administration, Portland, OR.